CHAPTER 5
DATA COMMUNICATION

Section I. DATA TRANSMISSION MEDIA

5-1. General

A number of different transmission systems and media can be used in an EMCS for communications between the CCU/CCC and FID/MUX and between the FID and MUX. These transmission systems include fiber optics, wire lines, coaxial cables, and radio frequency (RF).

5-2. Fiber optics

Fiber optics uses the wideband properties of infrared light traveling through transparent fibers. Fiber optics is a reliable communications media best suited for point-to-point high speed data transmission. Fiber optics is immune to radio frequency electromagnetic interference, and does not produce electromagnetic radiation emission; hence, fiber optics can be used in secure areas. Fiber optics DTM (not equipment) can be installed in explosive and flammable environments. Fiber optic cables can tolerate most severe weather conditions and can be immersed in many fluids. The bandwidth of this media is virtually unlimited, and extremely high data transmission rates can be obtained. The signal attenuation of high quality fiber optic cable is far lower than the best coaxial cables. Where repeaters are required nominally every 2000 feet for coaxial cable, they may be 1 to 2 miles apart in fiber optic systems.

5-3. Wire lines

a. Wire lines are twisted to pair that consist of two insulated conductors twisted together to minimize interference by unwanted signals.

b. Twisted pairs carry information over a wide range of speeds depending on line characteristics, to maintain a particular data communication rate, the line bandwidth, time delay, or the signal to noise ratio may require adjustment by conditioning the line. Twisted pairs are permanently hard-wired lines between the equipment sending and receiving data.

c. The nominal bandwidth of unconditioned twisted pairs is between 300 and 3000 Hz. For each Hz of available bandwidth, 2 bps may be transmitted. Data transmission in twisted pairs, in most cases, is limited to 1200 baud or less. Hardwired twisted pairs must be conditioned by the supplier in order to obtain operating speeds up to 9600 baud. Data transmission between FID and MUX can use line drivers operating at a speed selected by the system supplier.

5-4. Coaxial cable

Coaxial cable consists of a center conductor surrounded by a shield. The center conductor is separated from the shield by a dielectric. The shield protects against electromagnetic interference. Coaxial cables can operate at data transmission rates in the megabits per second range. Attenuation becomes greater as the data transmission rate increases. The transmission rates are limited by the data transmission equipment not be cable regenerative repeaters are required at specific intervals depending on the data rate, nominally every 2000 feet to maintain the signal at usable levels. Coaxial cable supports data rates in excess of 9600 baud.

5-5. RF

Modulated RF can be used as a DTM with the installation of radio receivers and transmitters. The use of RF will be coordinated with the communications officer to avoid interference with other existing or planned facility RF systems. MODEMs must be provided at each receiver/transmitted location. Frequency modulation is used instead of amplitude modulation because it is not susceptible to amplitude related interference. RF systems can be effectively used for two-way communications between the CCU/CCC and FID where other DTM is not available or suitable for the application. One-way RF systems can be effectively used to control loads at remote locations such as for unitary heaters in warehouses, and in family housing applications.

Section II. DATA TRANSMISSION HARDWARE

5-6. MODEM

The MODEM is a device which performs encoding and decoding of digital data by modulation and demodulation. The most commonly used format is frequency shift keying (FSK) of digital data into a series of ‘marks’ and ‘spaces’ represented by two audio tones. MODEMs are provided with sharply tuned filters which eliminate interference outside the normal pass band of the 'marks' and ‘spaces’ audio tones. MODEMs are used with all types of DTM

5-7. Line driver

A line driver is a hardware device which supplies sufficient output power to transmit digital signals over short distances, less than 250 feet with unbalanced lines or 3 miles with balanced lines, such as between FID and MUX. The line driver output is a low power output transistor. Optical isolators are used as protection devices in the line driver output.

5-8. Repeater

A repeater is a signal regenerator used at specified distances to restore signals to their proper level and quality. Repeater quantity, location, and specifications are selected according to the DTM characteristics and data speed.

5-9. RF terminals

The data signal enters a transmitter terminal where it modulates the RF carrier wave. After traveling through the DTM, the modulated RF carrier enters a receiver terminal, where it is amplified and demodulated back into the original data signal.

5-10. Fiber optic receiver-transmitter modules

The use of fiber optics in a data transmission system requires that optical data modules be provided to encode and decode digital data into the fiber optic DTM. The data signal modulates the light waves which are sent through the fiber optic DTM. The modulated light is received by a sensor and demodulated back into the original data signal. Light carrier waves are generated by light emitting diodes or lasers.

Section III. COMMUNICATIONS SYSTEMS APPLICATION

5-11. General

In the selection of the DTM and DTM layout, the EMCS designer will analyze the site requirements and select the appropriate DTM. The designer will normally select wire line or fiber optic DTM. In the cases where the designer wishes to use RF or coaxial cable DTM, prior approval from the design agency is required. In designing the DTM layout, the designer will not use any Government furnished DTM or data transmission hardware. When the designer uses wire line and fiber optic DTM, he will show, for each DTM circuit, a minimum of two pairs of wire lines or two optical fibers.

5-12. Communications officer coordination

a. The facility communications officer will be consulted regarding the installation of the proposed DTM layout. The coordination with the communications officer will include the following:

(1) Layout of the proposed DTM.

(2) Installation of the proposed DTM on existing poles or in existing ducts.

(3) Installation of the proposed DTM on new poles or in new ducts.

(4) Frequency allocation for the use of RF DTM.

b. The preliminary information described will be presented to the communications officer to document the EMCS requirements.

5-13. Communication system configuration

a. In developing a DTM layout, the designer will use the following requirements.

(1) Large system-no less than eight DTM circuits, and each circuit will have not more than 500 points including spare points. Each DTM circuit will have at least one FID.

(2) Medium system-no less than four DTM circuits, and each circuit will have no more than 500 points including spare points. Each DTM circuit will have at least one FID.

(3) Small system-no more than 125 points per DTM line.

(4) Micro system-one DTM circuit per remote RCU.

b. The designer will identify which facilities will have FIDs and which facilities will have MUXs. The contractor must have the option of substituting a FID for a MUX.

c. The designer will select locations for each FID and connected MUX so that no more than 125

points including required spares are to be connected to any FID/MUX group. Figure 5-1 illustrates a typical DTM layout.

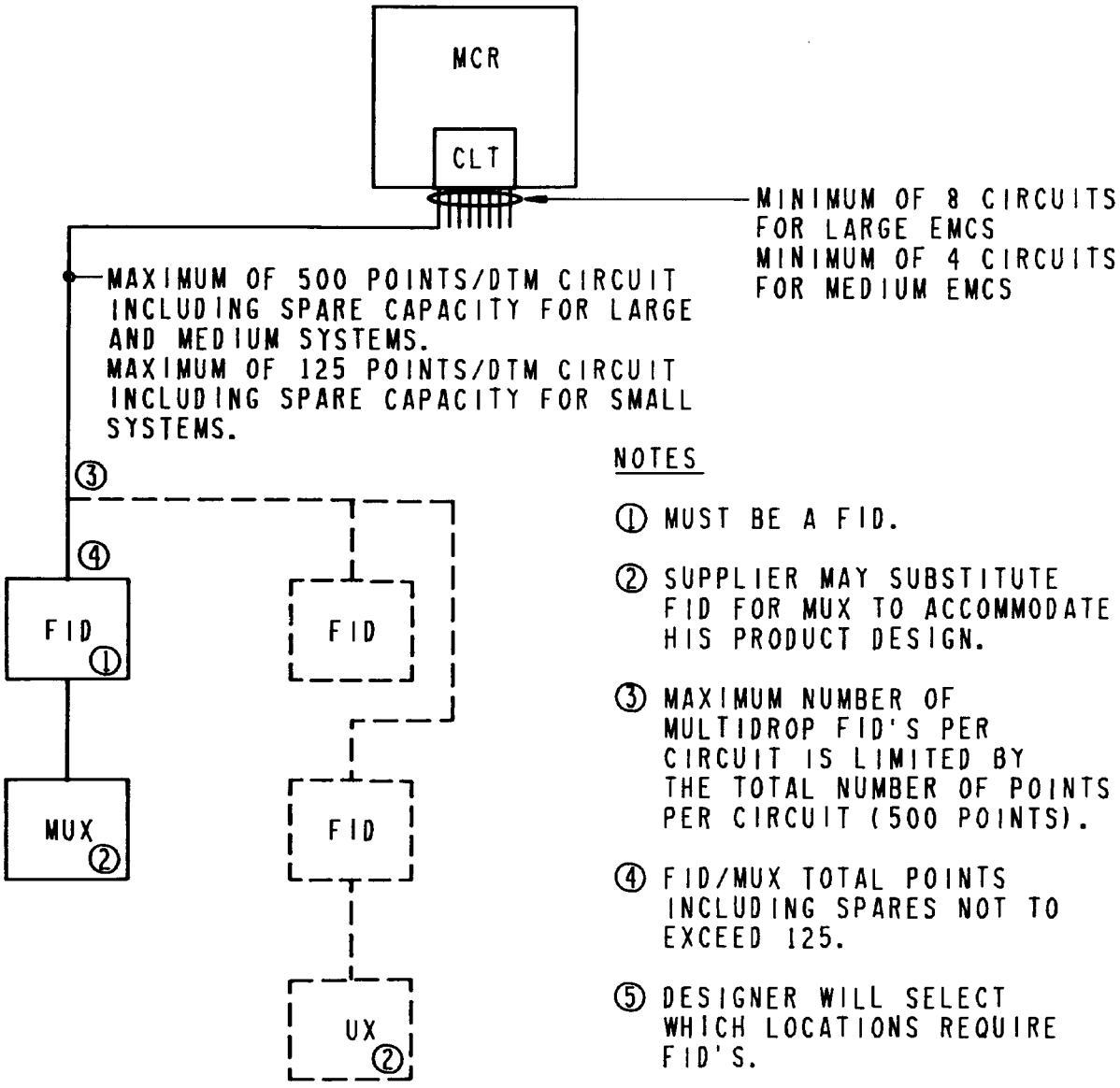

Figure 5-1. Figure EMCS DTM layout.

5-14. Reliability considerations

a. The most reliable data transmission scheme between FIDs and the CLT is fiber optics since it is impervious to EMI and FRI.

b. Data transmission media between FIDs and MUXs may *be* either wire line or fiber optics.

5-15. Data transmission rates

a. Communication between any FID/MUX on a wireline DTM circuit and the CLT will operate at no less than 1200 baud. DTM circuits using fiber optics will normally operate in excess of 9600 baud.

b. The transmission rate between the MUX panels and associated FIDs, may range from 1200 to 9600 baud.

5-16. Half duplex/full duplex data transmission

EMCS data transmission in most cases operates in a half duplex mode regardless of whether one or two DTM circuits are connected to a MODEM or fiber optics terminal. The use of full duplex or half duplex data transmission to meet system response time is a contractor selection.

5-17. DTM

The designer will design the system to require that the contractor furnish and install all the DTM required for the EMCS. The contractor must be responsible for the DTM during the warranty period.

5-18. Data transmission equipment

All the equipment required to transmit data via the DTM will be provided by the contractor.

5-19. Economic analysis

a. An economic analysis will be made to support the selection of the DTM and will consider installation costs and recurring maintenance costs over the economic life of the project. These costs will be included in the overall economic analysis for the project. Cost alone, however, will not necessarily be an overriding factor in the DTM selection.

b. RF DTM is applicable when the FID/MUX panel is located in remote areas with no other available DTM.

c. Fiber optics installation will be considered where there is a requirements for non-susceptibility to lightning, surges, or other forms of electromagnetic interference, or where the generation of electromagnetic interference emissions is required to be minimized for security purposes.